GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

no action as of 4/18 Off

Date: January 13, 1978

Project Title: Pyroceram Dielectric Constant Measurements

Project No: A-2087

Project Director: Mr. Joe M. Newton

Sponsor: General Dynamics - Pomona Division; Pomona, Calif. 91766

Agreement Period: From 12/6/77 Until 2/28/78 (Contr. Period)

Type Agreement: Fixed-Price Purchase Order No. P0064323 (Subcontract under N00024-77-C-5130)

Amount: $7,440.00

Reports Required: Final Report.

Sponsor Contact Person (s):

Technical Matters	Contractual Matters (thru OCA)
Mr. Ken Brooks Senior Buyer General Dynamics Corporation Pomona Division P.O. Box 2507 Pomona, Calif. 91766	

Defense Priority Rating: DO-A2 under DMS Reg. 1

Assigned to: Electromagnetics Laboratory (School/Laboratory)

COPIES TO:

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CA—3 (3/76)

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

no actions
ADS
Date: March 14, 1978

Project Title: Pyroceram Dielectric Constant Measurements

Project No: A-2087

Project Director: Mr. Joe M. Newton

Sponsor: General Dynamics - Pomona Division; Pomona, Calif. 91766

Effective Termination Date: 3/8/78(Final Report Sent)

Clearance of Accounting Charges: N/A - Fixed Price Agreement.

Grant/Contract Closeout Actions Remaining:

- X Final Invoice and Closing Document
- _ Final Fiscal Report
- _ Final Report of Inventions
- _ Govt. Property Inventory & Related Certificate
- _ Classified Material Certificate
- _ Other _____

Assigned to: Electromagnetics Laboratory (School/Laboratory)

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- Project Code (GTRI)
- Other _____

CA-4 (3/76)

Project A-2087

PYROCERAM DIELECTRIC CONSTANT MEASUREMENTS

Final Report

J. M. Newton

28 February 1978

Fixed-Price Purchase Order No. P0064323

Subcontract Under N00024-77-C-5130

Prepared for

General Dynamics Corporation
Pomona, California 91766

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

FOREWORD

This work was performed under Purchase Order P0064323 by the Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia for General Dynamics Corporation, Pomona Division. Mr. J. M. Newton was project director. Mr. W. R. Adams performed the measurements. The project monitor was Mr. H. P. Johnson.

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1.0 SUMMARY

Approximately one-hundred measurements of dielectric constant and loss tangent were made on eight samples of Corning Glass Works Pyroceram No 9606. These measurements were made over the temperature range of 75°F to 1200°F. Table 1 is a summary of the test results. The nominal room temperature dielectric constant was measured to be 5.51 with a loss tangent of 0.0008. The maximum value of dielectric constant observed was 5.94 (sample 8 at 1200°F) and the minimum value observed was 5.49 (sample 2 at room temperature).

Details of the test method and data are given in Section 2.0.

TABLE 1

SUMMARY OF MEASUREMENTS

Room Temperature Data			
Dielectric Constant			
Average		5.51	
Standard Deviation		0.02	
Loss Tangent			
Average			0.0008
Standard Deviation			0.00007
Elevated Temperature Data			
Dielectric Constant (Overall Samples)			
Minimum	(75°F)	5.51	
Maximum	(1200°F)	5.88	
Loss Tangent (All Samples)			
Minimum	(75°F)		0.0008
Maximum	(1200°F)		0.0034
Dielectric Constant/Loss Tangent			
Sample 1			
Minimum	(75°F)	5.51/0.0007	
Maximum	(1200°F)	5.86/0.0034	
Sample 2			
Minimum	(75°F)	5.49/0.0009	
Maximum	(1200°F)	5.86/0.0033	
Sample 3			
Minimum	(75°F)	5.50/0.0008	
Maximum	(1200°F)	5.82/0.0032	
Sample 4			
Minimum	(75°F)	5.49/0.0009	
Maximum	(1200°F)	5.86/0.0034	
Sample 5			
Minimum	(75°F)	5.53/0.0009	
Maximum	(1200°F)	5.88/0.0035	
Sample 6			
Minimum	(75°F)	5.53/0.0009	
Maximum	(1200°F)	5.88/0.0036	
Sample 7			
Minimum	(75°F)	5.54/0.0008	
Maximum	(1200°F)	5.90/0.0034	
Sample 8			
Minimum	(75°F)	5.52/0.0007	
Maximum	(1200°F)	5.94/0.0036	

2.0 TEST SETUP AND TEST RESULTS

Eight Pyroceram samples have been measured to determine their dielectric constants and loss tangents as a function of temperature. These measurements were made by the short circuited waveguide technique at a frequency of 10.0 GHz. A block diagram of this setup is shown in Figure 1.

The variations in the dielectric constants and loss tangents at room temperature for the eight samples are shown in Figures 2 and 3. The data points given in these figures are the averages of several measurements. The standard deviation for these measurements are given adjacent to each data point on the graphs.

Figures 4 and 5 show the average changes in the dielectric constants and loss tangents for the eight samples as the temperature is varied.

Figures 6 through 11 show the variation of the dielectric constant of each sample as function of temperature. Similar curves for the loss tangent are not given since the differences between individual samples were small.

The dielectric constant appears to vary linearly with temperature. Table 2 gives the values of the straight line which fits the measured data.

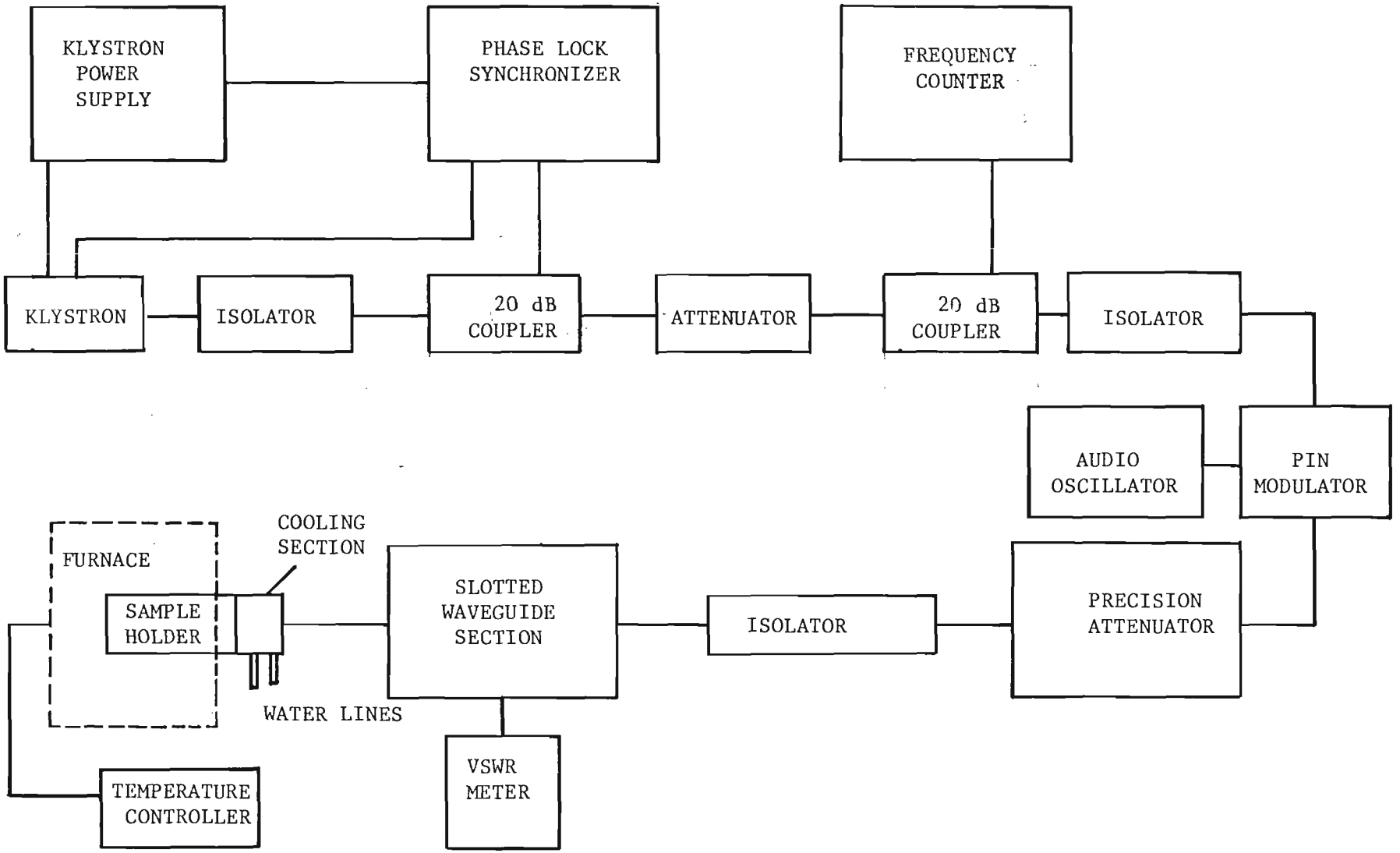


Figure 1. Block Diagram of Short Circuited Waveguide Set-Up.

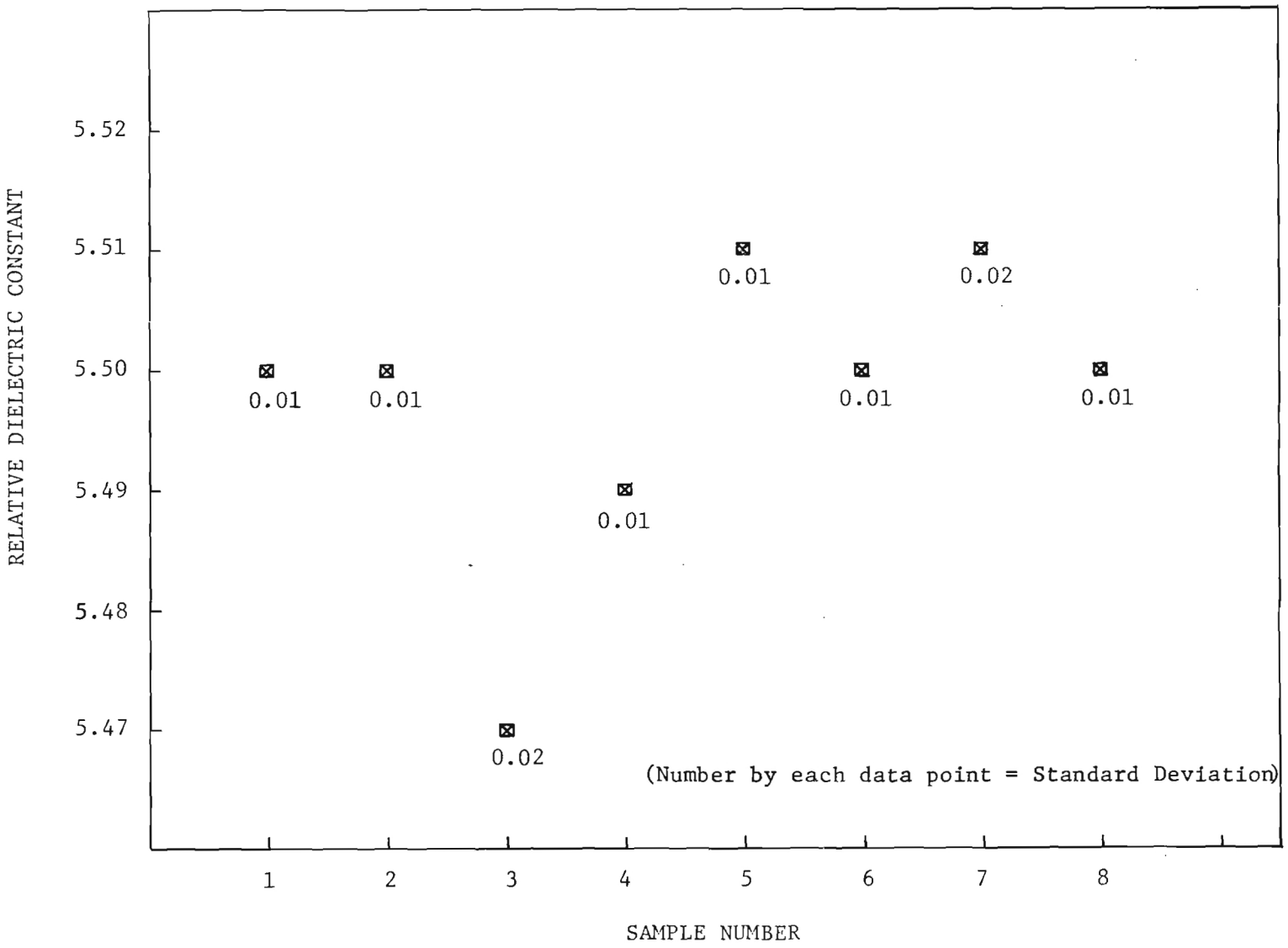


Figure 2. Relative Dielectric Constant as Determined by Five Measurements at Room Temperature (75°F).

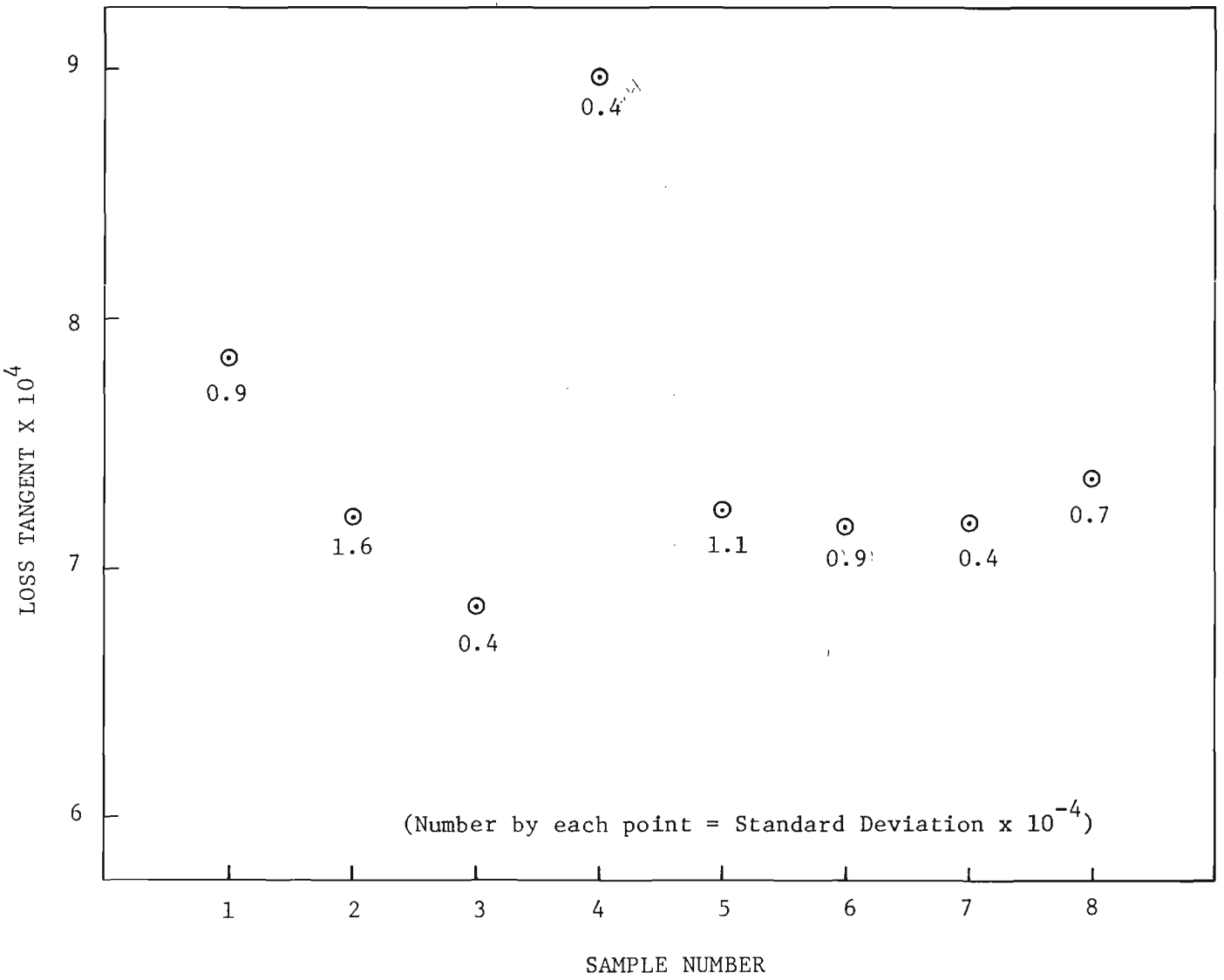


Figure 3. Loss Tangent as Determined by Five Measurements at Room Temperature (75°F).

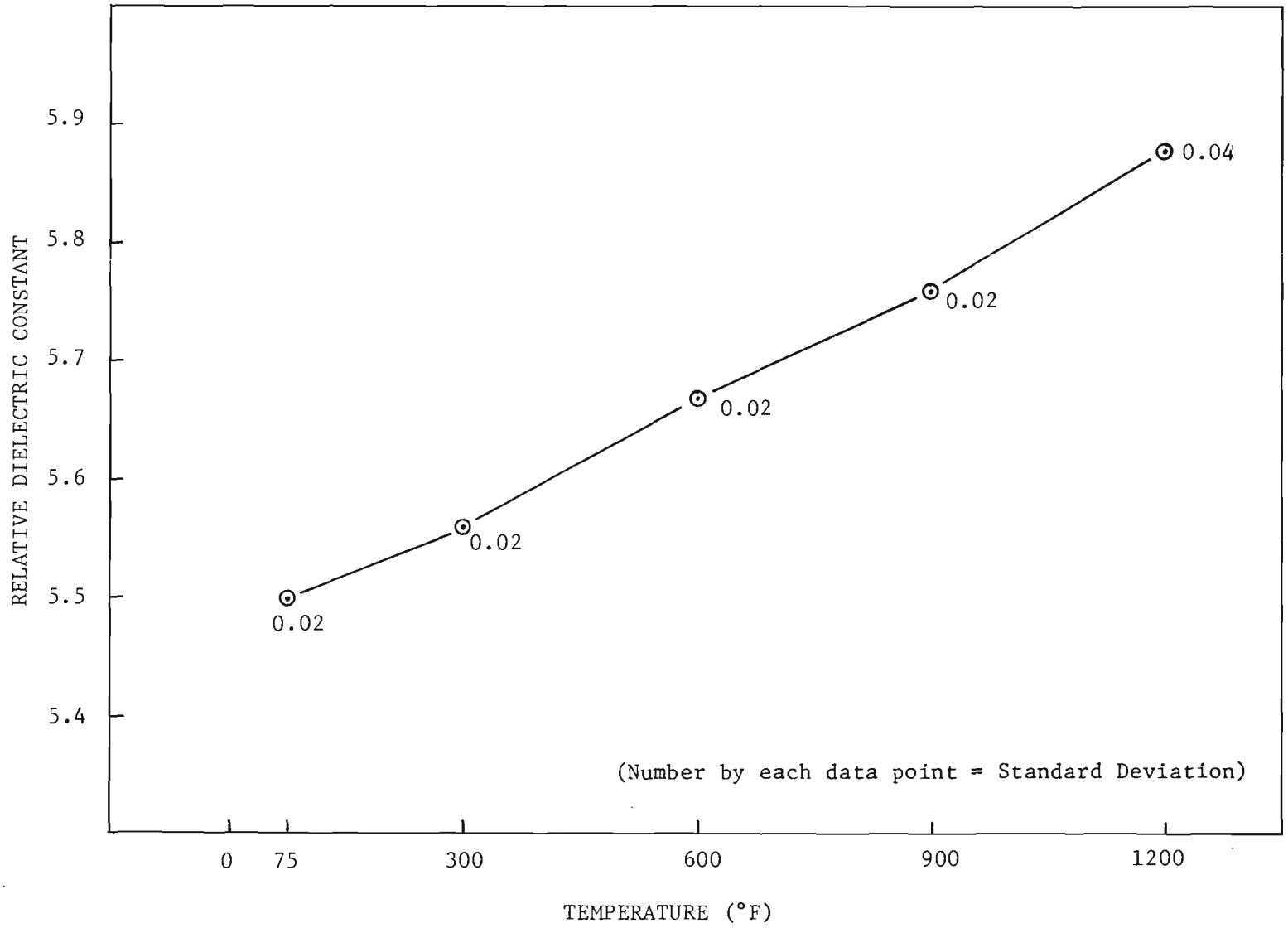


Figure 4. Average Dielectric Constant of all 8 Samples versus Temperature.

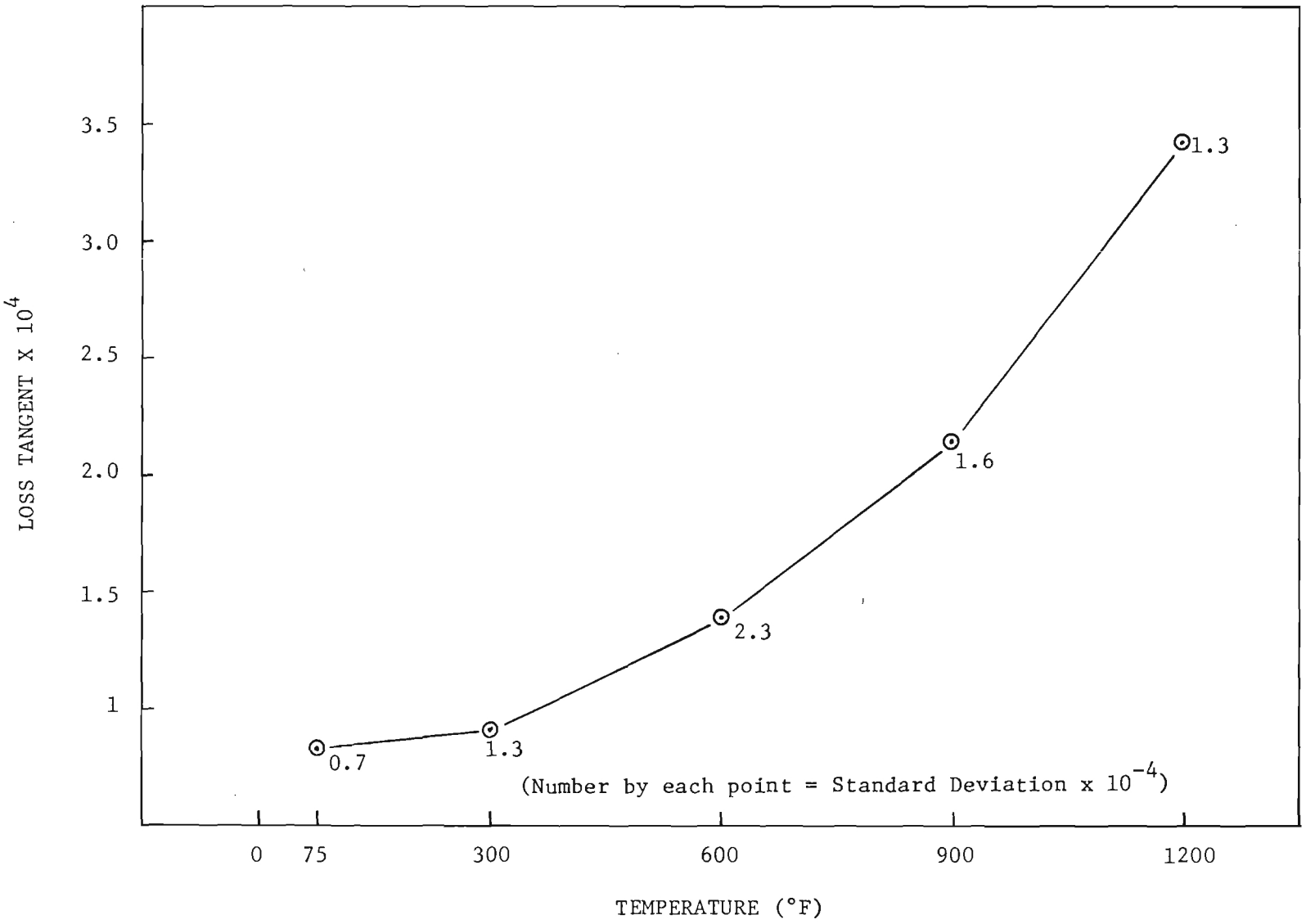


Figure 5. Average Loss Tangent for all 8 Samples versus Temperature.

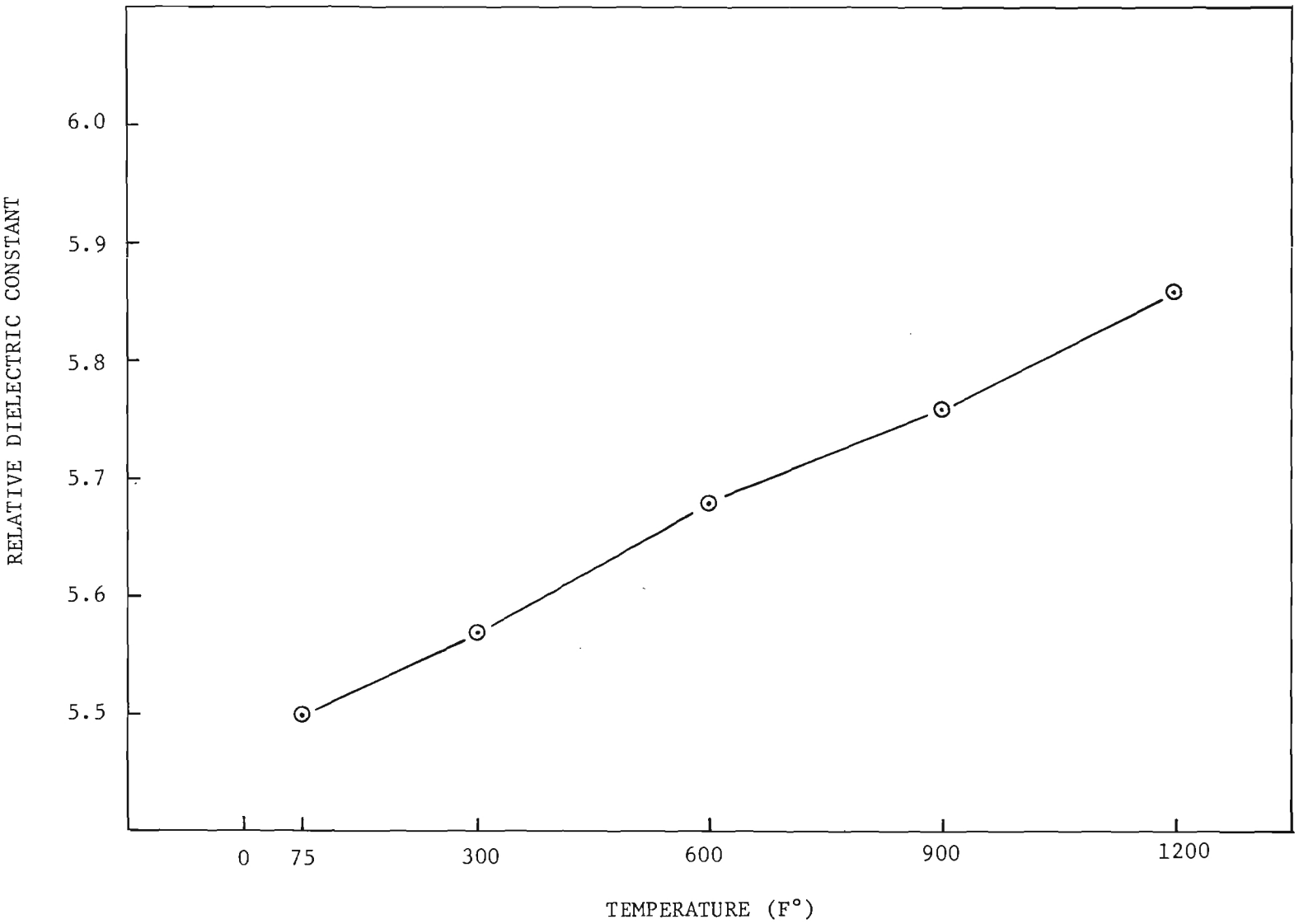


Figure 6. Dielectric Constant versus Temperature for Sample No. 1.

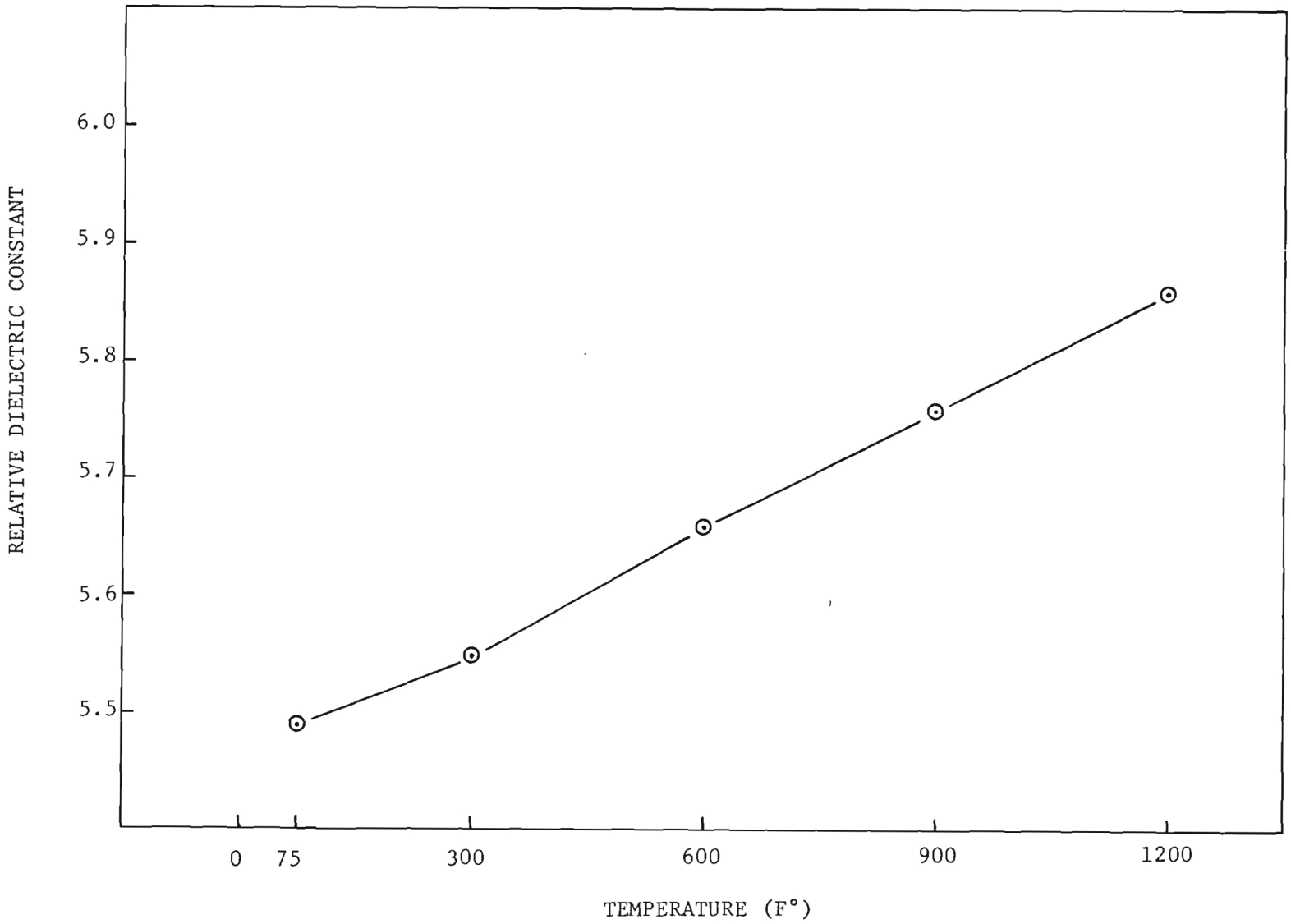


Figure 7. Dielectric Constant for Samples No. 2 and 4 versus Temperature.

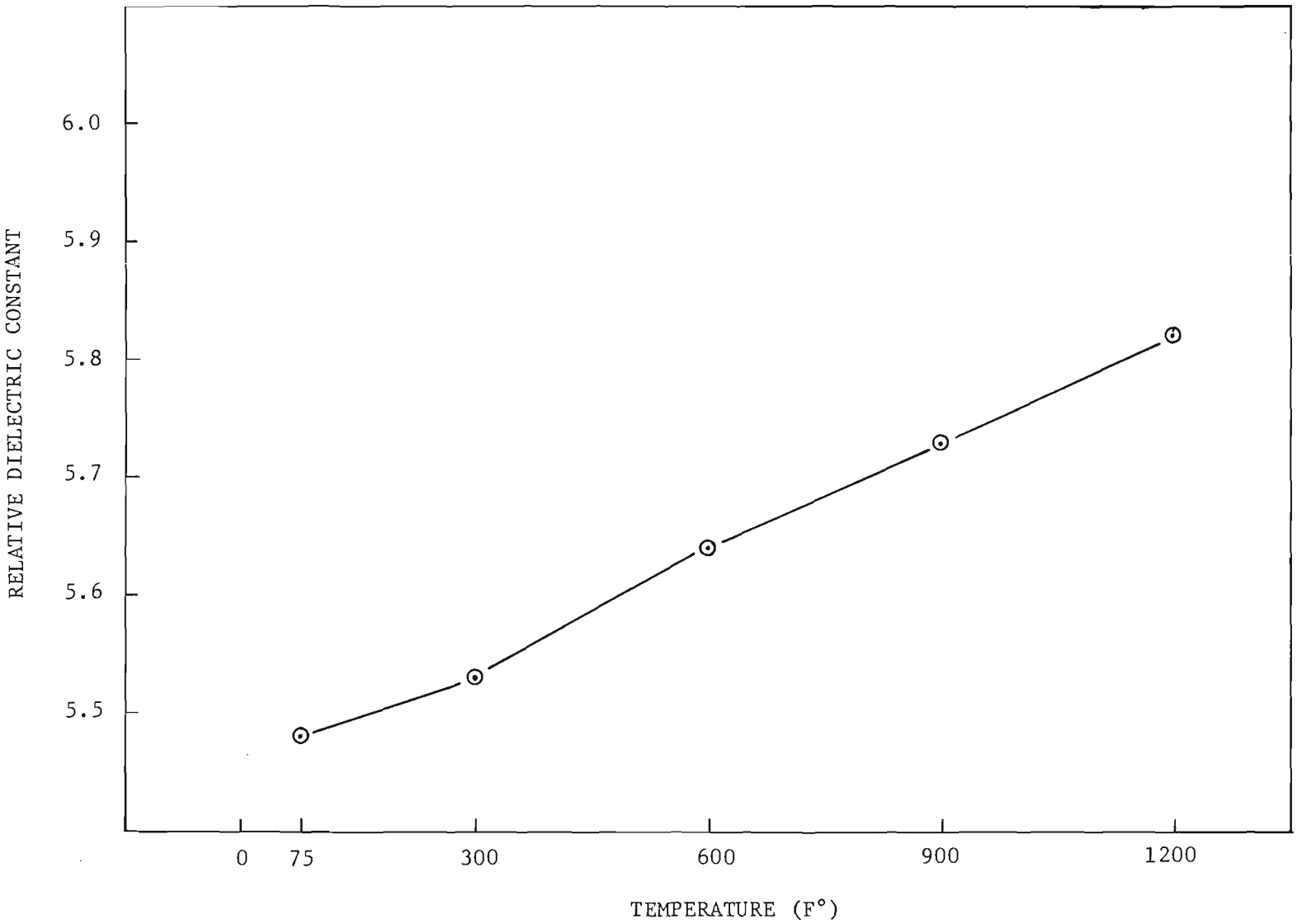


Figure 8. Dielectric Constant for Sample No. 3 versus Temperature.

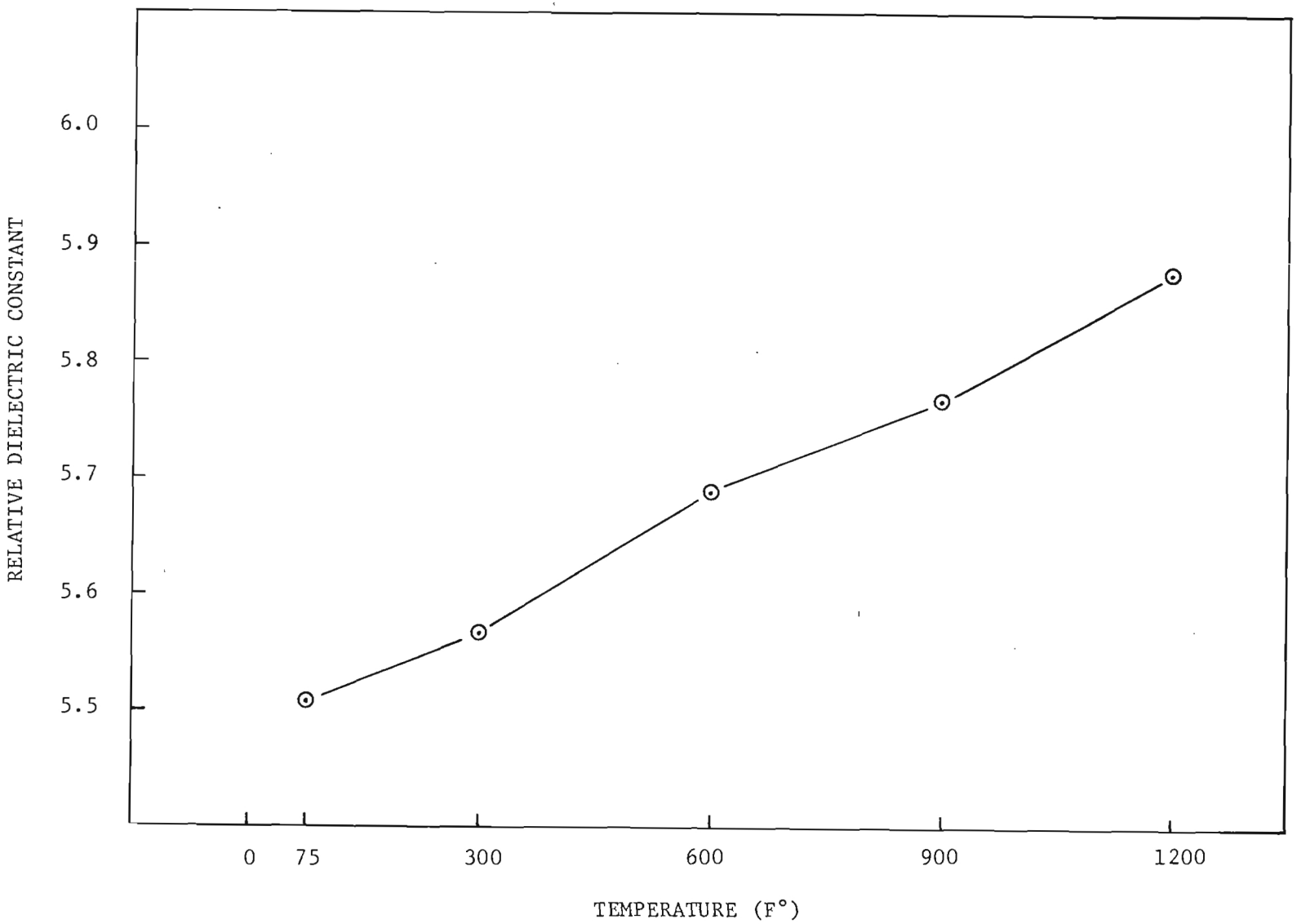


Figure 9. Dielectric Constant for Samples No. 5 and 6 versus Temperature.

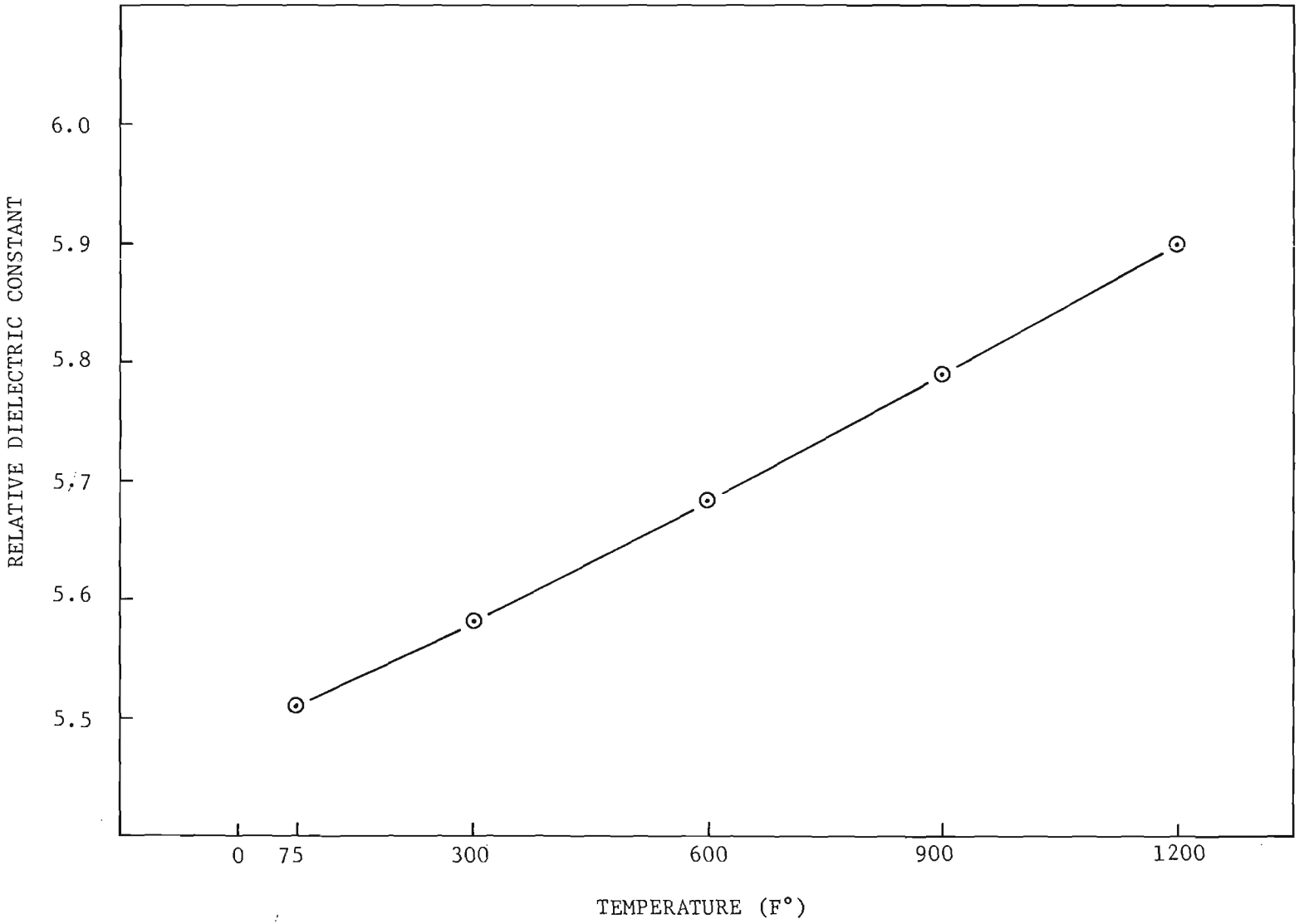


Figure 10. Dielectric Constant of Sample No. 7 versus Temperature.

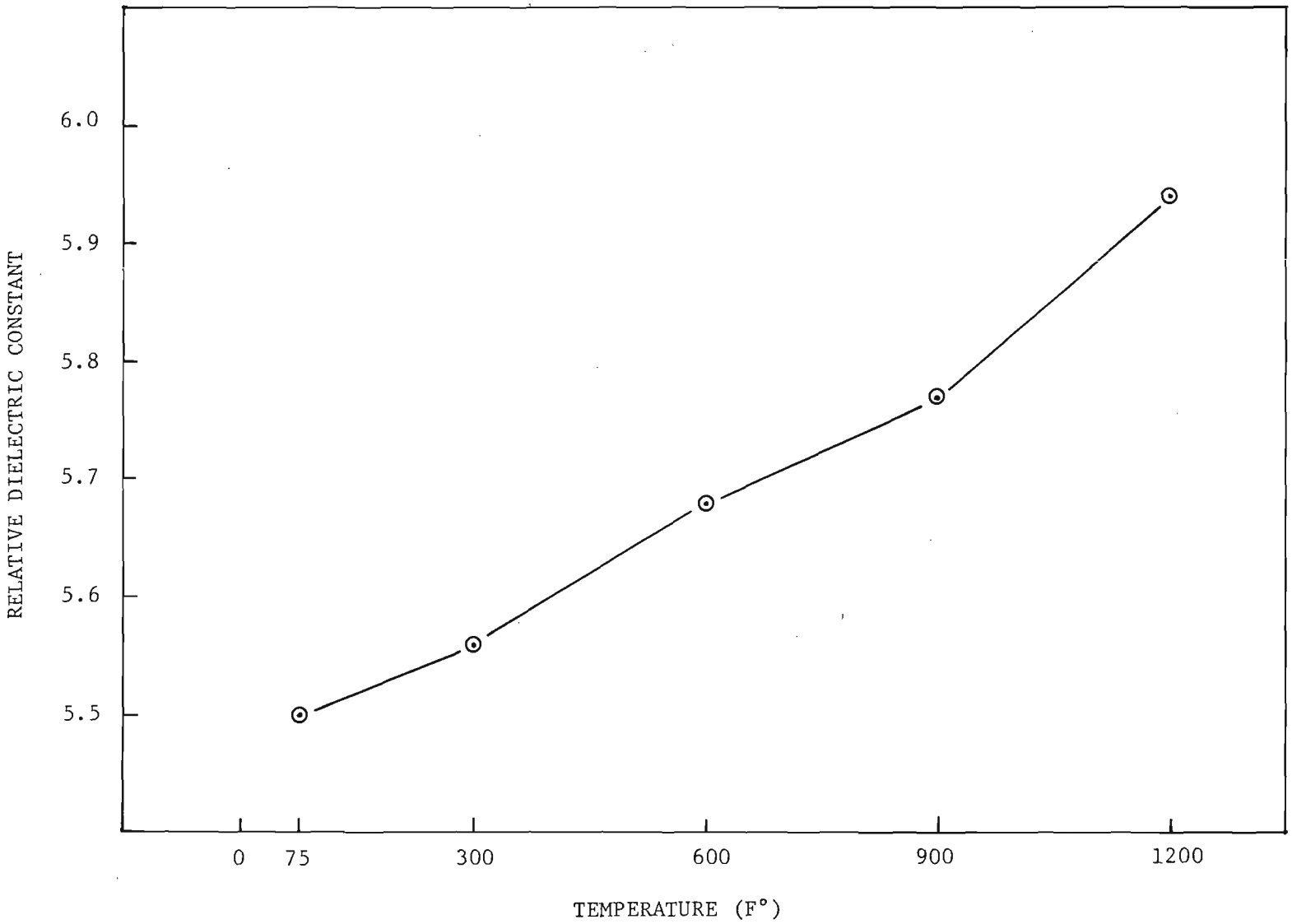
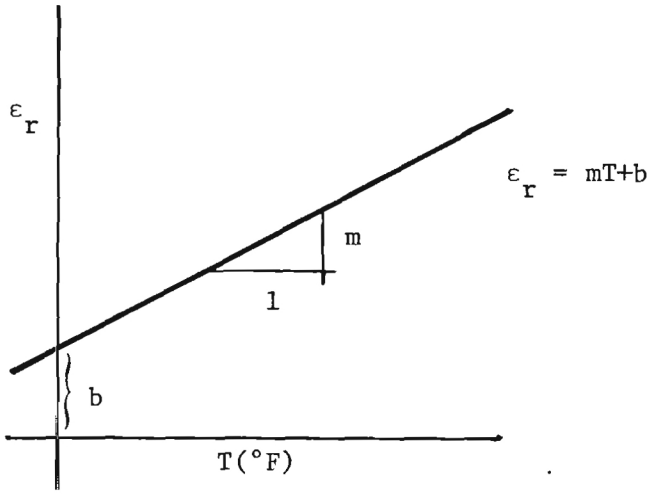


Figure 11. Dielectric Constant of Sample No. 8 versus Temperature.

TABLE 2

STRAIGHT LINE PARAMETERS OF
MEASURED DIELECTRIC CONSTANTS



a) General Straight Line

SAMPLE	m	b
Aggregate	$3.378.10^{-4}$	5.475
1	$3.200.10^{-4}$	5.476
2	$3.378.10^{-4}$	5.455
3	$2.844.10^{-4}$	5.469
4	$3.378.10^{-4}$	5.455
5	$3.289.10^{-4}$	5.485
6	$3.289.10^{-4}$	5.485
7	$3.556.10^{-4}$	5.473
8	$3.911.10^{-4}$	5.451

b) Straight Line Parameters